

Exercise	1	2	Total
100%	6	6	12
Points			

Name:

Extragalactic Astronomy and Cosmology

Homework 3 - Lecture 7 - Curved space

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Due date: September 26

1 Areas in curved space

Consider an equilateral triangle, with sides of length L , drawn on a two-dimensional surface of constant curvature.

- Can you draw an equilateral triangle of arbitrarily large area A on a surface with $\kappa = +1$ and radius of curvature R ? If not, what is the maximum possible value of A ?
- Can you draw an equilateral triangle of arbitrarily large area A on a surface with $\kappa = 0$? If not, what is the maximum possible value of A ?
- Can you draw an equilateral triangle of arbitrarily large area A on a surface with $\kappa = -1$ and radius of curvature R ? If not, what is the maximum possible value of A ?

If you have problems with this exercise, read Ryden Section 3.2

2 Coordinate systems

Demonstrate that

$$ds^2 = dx^2 + dy^2 + dz^2 \quad (1)$$

represents the same metric as

$$ds^2 = dr^2 + r^2[d\theta^2 + \sin^2\theta d\phi^2] \quad (2)$$

Hint: Use the substitutions

$x = r \sin\theta \cos\phi$, $y = r \sin\theta \sin\phi$, $z = r \cos\theta$
and remember that $dx^2 \equiv (dx)^2$